

REMARKS

Upon entry of this amendment, claims 1-7, 17, and 65-69 will be pending. Claims 31 and 43 have been withdrawn.

No additional claim fees are believed to be due because there are currently 5 new claims that have been added, and 56 claims have been canceled; but if any fees are due the Patent Office is authorized to charge deposit Account No. 19-1345

Applicants respectfully request reconsideration and allowance of all pending claims.

I. Status of Pending Claims

Claims 1-7 and 17 remain pending in the present application. Claims 65-69 are new.

Claims 1 and 17 have been amended. Support for the amendments to claims 1 and 17 with regard to defining superfilling as rapid bottom up deposition can be found in applicants' specification at ¶[0017].

Claims 31 and 43 have been canceled.

Claims 65-69 have been added. Support for new claim 65 with respect to the sulfuric acid concentration can be found in applicants' specification at ¶[0035]. Support for new claim 66 with respect to the copper sulfate pentahydrate and its concentration can be found in applicants' specification at ¶[0035]. Support for new claims 67-69 with respect to the concentration of the defect reducing agent can be found in applicants' specification at ¶[0023].

II. §112 Rejection of Claims 1-7 and 31

Reconsideration is requested of the §112, second paragraph, rejection of Claims 1-7 and 31. Claim 1 was amended to respond to the rejection, and applicants respectfully submit that claims 1-7 are not indefinite. The rejection with respect to claim 31 has been rendered moot because claim 31 has been canceled.

III. §102(b) Rejection of Claims 31 and 43 over Creutz et al.

The rejection of claims 31 and 43 as being anticipated by Creutz et al. (U.S. 4,110,176) has been rendered moot because the claims have been canceled.

IV. §103(a) Rejection of Claims 1-7 and 17 over Barstad et al. in combination with Creutz et al.

Reconsideration is requested of the rejection of claims 1-7 and 17 as being obvious over Barstad et al. (U.S. 6,444,110) in combination with Creutz et al. (U.S. 4,110,176). Applicants' respectfully submit that for the reasons discussed below, the Office's combination of references is improper because (A) Creutz et al. is non-analogous art and cannot fairly be relied on in a §103(a) rejection, and (B) there is no motivation in the references to combine reference teachings to arrive at the invention described by applicants' claims.

IV.A. Creutz et al. is Non-Analogous Art

The Creutz et al. process and chemistry are for plating printed circuit boards (PCBs) (Col. 2, line 8-23),

and are not for plating semiconductor integrated circuit device substrates.

Per MPEP 2141.01(a), a reference may be relied upon as a basis for a §103(a) rejection only if it is analogous prior art, which includes references either (1) in the field of the applicants' endeavor, or (2) that are reasonably pertinent to the particular problem with which the applicants were concerned. In this particular instance, the Creutz et al. patent was based on an application filed nearly 30 years ago and related to copper plating in the manufacture of PCBs. Printed circuit boards of 30 years ago (and even PCBs of today) are not in the same field as applicants' copper filled vias and trenches of integrated circuits. Printed circuit boards are relatively large substrates that electronic components are mounted onto and then electrically connected to each other by wiring formed by printing copper patterns. Printed circuit boards are typically a resinous material several inches on a side.

In contrast to PCBs, an integrated circuit is a combination of interconnected individual circuit elements inseparably associated with each other within a continuous substrate. An IC is a semiconductor material such as SiO₂ typically only several millimeters on a side or smaller; it is not a resinous material. Copper is deposited with the goal of completely filling vias and trenches with openings of submicron size, e.g., **0.5 microns and lower**, which serve as micro, solid-state interconnects between microelements. (Applicants' specification, at ¶[0003]).

PCBs are resin-based macro-scale carriers of electronic signals between electronic components; whereas ICs are semiconductor-based miniaturized electronic

components. By analogy, PCBs are an interstate highway system; whereas ICs are automobiles on that highway. These respective substrates are therefore disparate in terms of material properties, character, and function.

Inasmuch as plating of PCBs and filling vias and trenches in ICs are distinct fields of endeavor, therefore, Creutz et al. cannot fairly be relied on under the first analogous art test of MPEP 2141.01(a).

Having failed the first condition under MPEP 2141.01(a), Creutz et al. can only be applied as a basis for rejection under §103(a) if it is "reasonably pertinent to the particular problem with which the inventors were concerned." *In re Oetiker*, 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992). In this instance, the problem with which the inventors were concerned was filling submicron sized reliefs, such as vias and trenches, with Cu. In copper filling of vias and trenches it is necessary to "superfill," i.e., deposit Cu into the feature substantially faster in the vertical direction than in the horizontal direction. That is, it is necessary to plate faster from the bottom up than on the feature side walls. Claims 1 and 17 have been amended to underscore this "superfilling" aspect of the invention.

What is required in superfilling is non-conformal deposition, i.e., deposition which does not conform to the shape of the features on which it is plated. In contrast, non-conformal deposition is not an overriding concern in depositing Cu onto PCBs. Rather, generally conformal deposition is desired in Cu plating PCBs. In other words, the problem encountered by applicants and others seeking to deposit Cu into submicron-sized IC features is to force a deposition mechanism which is substantially faster in the

vertical direction than in the horizontal direction. That is "superfilling," a problem about which Creutz et al. were conspicuously silent. This silence, moreover, is understandable in view of the disparate nature of PCBs and IC substrates in terms of character and function. This distinction between the overall goals of the processes -- conformal deposition versus non-conformal superfilling -- is so fundamental that it establishes that Creutz et al. is not "reasonably pertinent to the particular problem [i.e., non-conformal superfilling] with which the inventor was concerned."

As plating copper on PCBs addresses a wholly different set of concerns, one addressing applicants' problem of superfilling submicron-sized features on semiconductor IC substrates would not have reasonably looked to Creutz et al. to provide guidance. The Creutz et al. patent states that the chemistries of that reference "find appreciable utilization in the manufacture of printed circuit board." Creutz et al. does NOT suggest electroplating copper into submicron-sized reliefs of IC semiconductors. Therefore, Creutz et al. cannot fairly be deemed to be analogous art to claims 1-7 and 17 because the problems encountered by Creutz et al. are not reasonably pertinent to those encountered by the applicants.

**IV.B. There is No Suggestion or Motivation to
Combine Reference Teachings.**

Even if the Creutz et al. reference were either in the same field or reasonably pertinent to the same problem as claims 1-17 and 17, Barstad et al. and Creutz et al. do not render the subject matter of claims 1-7 and 17 obvious

because there is no suggestion or motivation to combine reference teachings, that is, to modify the Barstad process by incorporating the proposed compound from Creutz et al. In the context of establishing a prima facie case of obviousness under §103(a),

First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. MPEP 2143, first paragraph.

It is asserted in the Office Action at page 8 that because Barstad et al. teach that "a wide variety of brighteners, including known brightening agents, may be employed in copper electroplating compositions" useful to plate circuit board substrates with small diameter, high aspect ratio microvias and other apertures, the compositions comprising such brighteners will also be useful for plating integrated circuit devices, such as semiconductor devices, relying on Barstad et al.'s text in columns 7 and 8. But, Barstad et al. teach that a **particular composition** was found to have benefits with regard to PCB and IC semiconductor substrate technologies. That is, Barstad et al. teach that their compositions and additives are useful for plating both types of substrates; but they do not suggest anything about the applicability of any other additives, such as Creutz et al.'s additives. Barstad et al. state that "a wide variety of substrates may be plated with **the compositions of the invention.**" The following sentence of the passage elaborates on this statement by stating that "the **compositions of the invention** are particularly useful to plate **difficult work pieces**, such as **circuit board substrates with small**

diameter, high aspect ratio microvias and other apertures...[as well as] integrated circuit devices, such as formed semiconductor devices and the like." (Col. 7, lines 56-65.) Elsewhere in the Barstad et al. patent, it is stated that "a number of improvements in electroplating techniques have been made *as the articles to be plated [have] evolved in degree of difficulty*" (Col. 1, lines 29-65). Thus, the "difficult work pieces" referred to above can fairly be understood to mean modern substrates.

Based on the asserted utility for the particular composition claimed in the Barstad et al. patent, i.e., the plating of modern PCB and IC semiconductor substrates, Barstad et al. cannot fairly be deemed to have now broadly made it obvious as a general, sweeping proposition to employ *any PCB plating composition* whatsoever *for superfilling modern IC semiconductor substrates*. That is, Barstad et al. cannot fairly stand for the broad notion that any copper plating composition that is useful to plate a circuit board substrate will also be useful for plating today's integrated circuit devices, i.e., devices with submicron-sized features, and for solving superfilling problems. Moreover, Barstad et al. make no suggestion, express or implied, that plating chemistries formulated for plating PCBs (whether today or 30 years ago) can be applied successfully to modern semiconductor integrated circuit device substrates. Even granting that "the mere age of...references is not persuasive of the unobviousness of the combination of their teachings...[,]"¹ the Barstad et al. patent makes no suggestion to modify its process by employing the additives disclosed in Creutz et al. because

¹ Applicants acknowledge that the age of the Creutz et al. reference is not disqualifying. But, in combination with Barstad et al., it does not render claims 1-7 and 17 obvious for the reasons stated herein.

they are of no special value for plating IC semiconductor substrates generally, or in particular those characterized by small diameter, high aspect ratio microvias or other submicron sized reliefs.

Since (1) Creutz et al. is non-analogous art and cannot fairly be relied on in a §103(a) rejection, and (2) there is no motivation to modify the Barstad et al. process by incorporating the proposed compound from Creutz et al., it necessarily follows that the combination of Creutz et al. and Barstad et al. fails to render claims 1-7 and 17 obvious. Accordingly, applicants respectfully request withdrawal of the rejection.

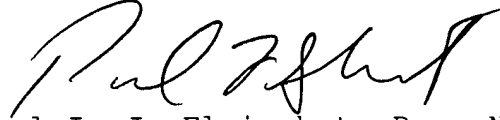
V. New Claims 65-69

New claims 65-69 depend from claim 1 and are patentable for the same reasons as claim 1 and by virtue of the additional requirements therein.

CONCLUSION

In view of the foregoing, applicants respectfully
request allowance of claims 1-7, 17, and 65-69.

Respectfully submitted,



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